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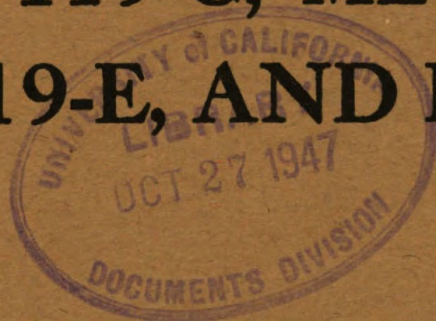
TM 11-2423

AR DEPARTMENT TECHNICAL MANUAL

U.S. Dept. of Army

CLINOMETERS

ML-119-C, ML-119-D,
ML-119-E, AND ML-119-F



RESTRICTED. DISSEMINATION OF RESTRICTED
MATTER. No person is entitled solely by virtue of his grade or
position to knowledge or possession of classified matter. Such
matter is entrusted only to those individuals whose official duties
require such knowledge or possession. (See also paragraph 23b,
AR 380-5, 15 March 1944.)

AR DEPARTMENT

6 JANUARY 1945

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WAR DEPARTMENT

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WAR DEPARTMENT,
WASHINGTON 25, D. C., 6 JANUARY 1945.

TM 11-2423, Clinometers ML-119-C, ML-119-D, ML-119-E, and ML-119-F, is published for the information and guidance of all concerned.

[A. G. 300.7 (2 Dec. 44).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

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(For explanation of symbols see FM 21-6.)

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DESTRUCTION NOTICE

WHY —To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN—When ordered by your commander.

HOW —1. Smash — Use sledges, axes, handaxes, pickaxes, hammers, bars, heavy tools.

2. Cut — Use axes, handaxes, machetes.

3. Burn — Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives — Use firearms, grenades, TNT.

5. Disposal — Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT—1. Smash — Sighting tube, quadrant, pendant.

2. Cut — Cross wires.

3. Burn — This manual, carrying case.

4. Bury or Scatter — Any or all of the above pieces which remain.

DESTROY EVERYTHING

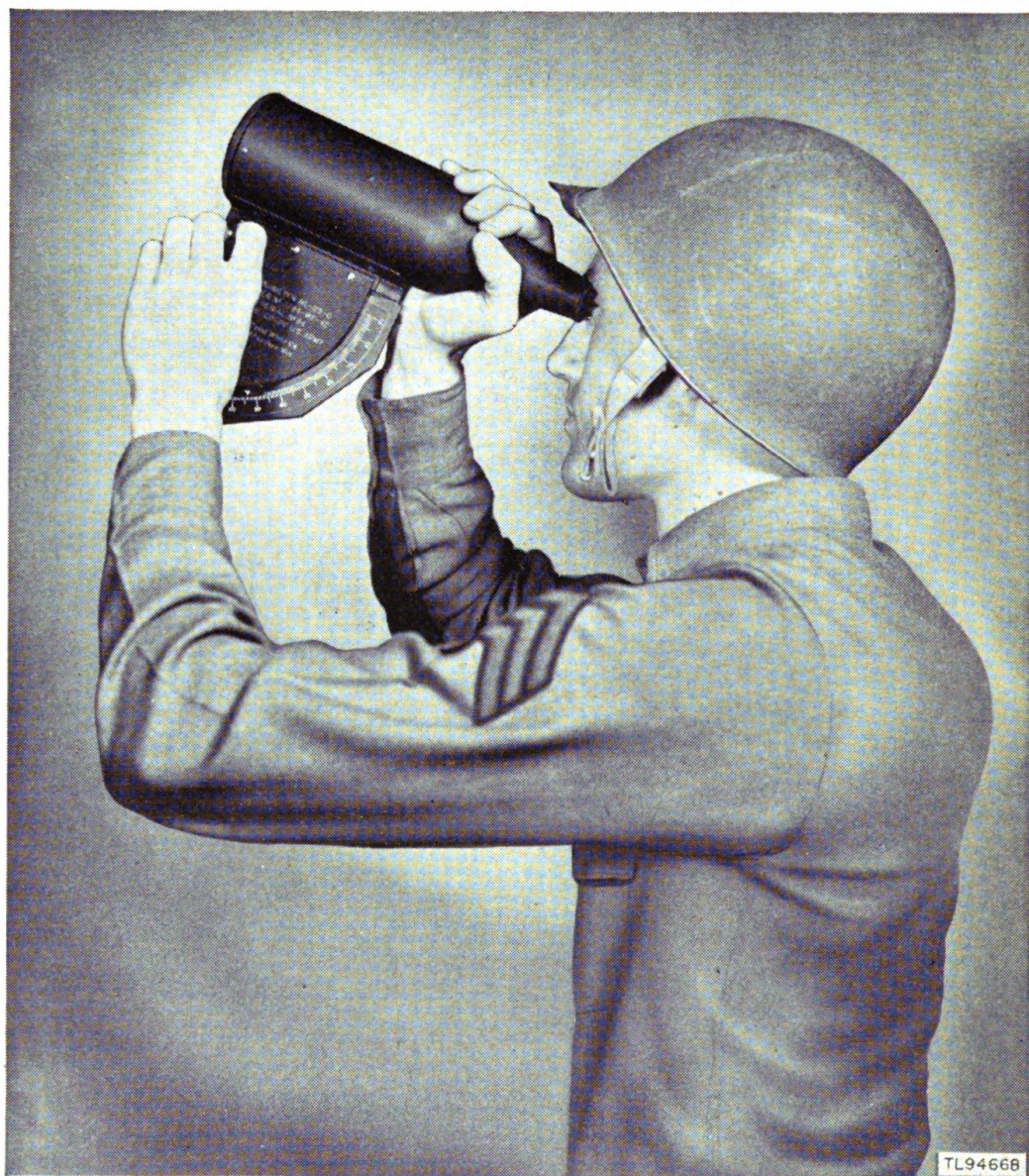


Figure 1. Clinometer ML-119-(), in use.*

RESTRICTED

PART ONE

INTRODUCTION

SECTION I

DESCRIPTION OF CLINOMETER ML-119-(*).

1. GENERAL.

a. Clinometers ML-119-C, -D, -E, and -F are optical instruments without lenses which measure an angle of elevation.

b. Basic type nomenclature followed by an asterisk within parentheses, that is, Clinometer ML-119-(*), denotes any or all Clinometers ML-119-C, -D, -E, or -F.

2. APPLICATION.

Clinometer ML-119-(*) is used to determine the angle of elevation of a spot of light thrown on the base of a cloud by a ceiling light projector located at the opposite end of a measured base line (fig. 4). Data thus obtained are used in computing ceiling height (cloud height).

3. TABLE OF COMPONENTS (fig. 2).

Quan.	Component	Dimensions (in.)			Volume (cu ft)	Weight (lb)
		Length	Width	Height		
1	Clinometer consisting of:					2- $\frac{1}{4}$
	Sighting tube	9- $\frac{1}{2}$	3		0.05	
	Quadrant plate assembly	5- $\frac{1}{4}$	2- $\frac{3}{8}$	5- $\frac{5}{8}$	0.03	
1	Carrying case	10- $\frac{3}{4}$	9- $\frac{5}{8}$	4- $\frac{1}{4}$	0.25	3- $\frac{1}{4}$
					Total weight	5- $\frac{1}{2}$

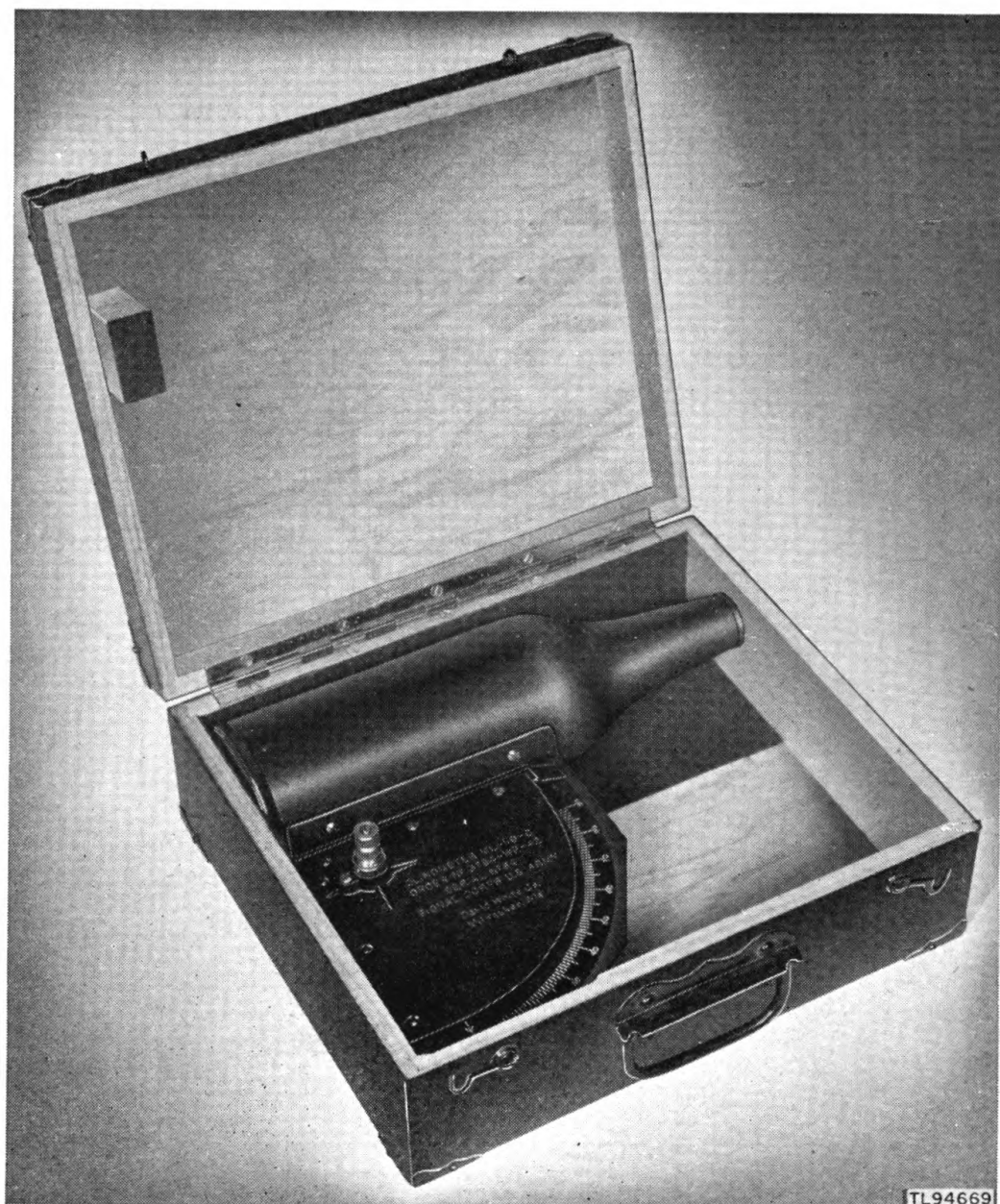


Figure 2. Clinometer in carrying case.

4. CLINOMETER ML-119-(*) (fig. 3).

The clinometer consists of a sighting tube and a quadrant plate assembly. It is made of metal and has a dull black finish inside and out. The instrument is kept in a plywood carrying case when not in use.

a. Sighting Tube. The sighting tube is bottle-shaped and has a peep sight $\frac{1}{4}$ -inch in diameter at the tapered end which is held against the eye. The outer end is 3 inches in diameter to permit a view of the surrounding dark sky as well as the light

spot. A pair of cross wires on the larger end aids the observer in centering the light spot.

b. Quadrant Plate Assembly (fig. 3). (1) The quadrant plate assembly is attached to the sighting tube by four screws. It consists of the quadrant plate, the quadrant plate cover, the pendant, the pendant clutch spring, the pendant stud, the pendant clutch clamp, and the adjusting nuts and locknuts for these parts.

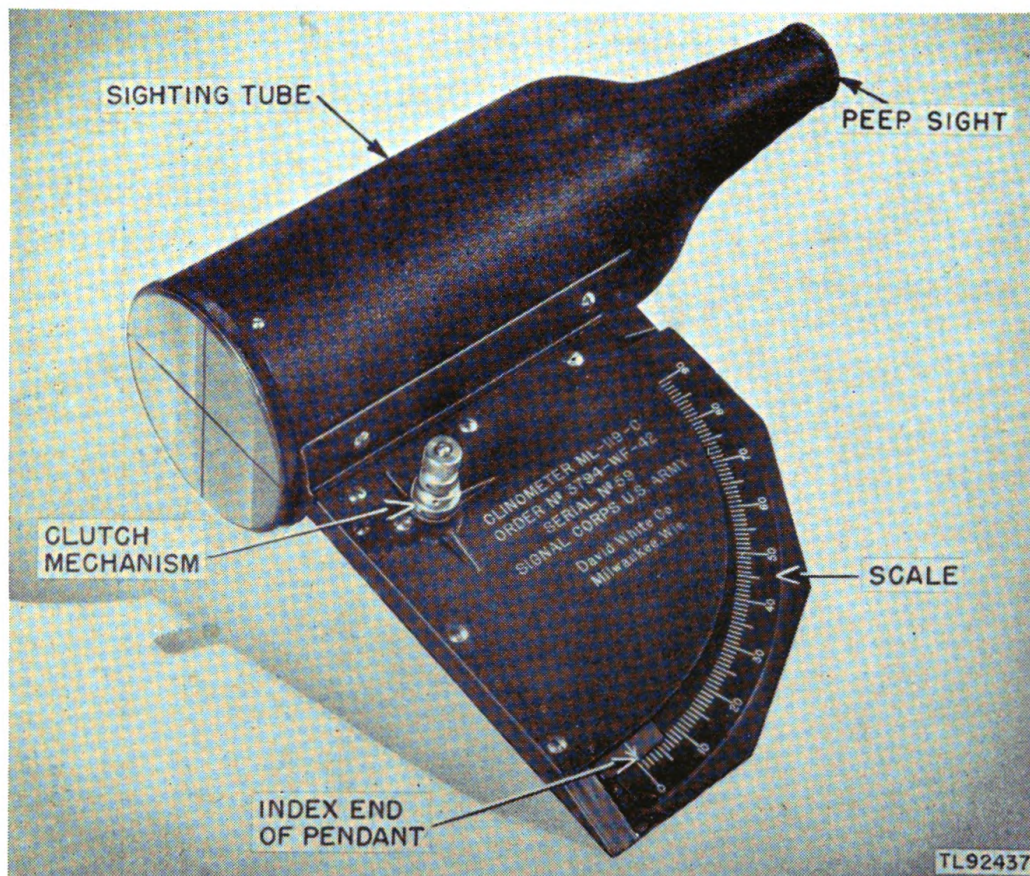


Figure 3. Clinometer ML-119-C. (Clinometers ML-119-D and ML-119-E are identical to Clinometer ML-119-C. Clinometer ML-119-F has no cover glass.)

(2) The quadrant is fastened longitudinally to the sighting tube and carries a pendant suspended on a horizontal axis to indicate the angular inclination of the clinometer. The quadrant scale is graduated in 1° intervals from 0° to 90° , and is marked radially from the pivot point of the quadrant. Scale markings are in white. The pendant is concealed by the quadrant plate, except for the end which contains the index mark. This free end of the pendant moves along the quadrant scale. The sight-line between the center of the peep sight and the intersection

of the cross wires is perpendicular to a line through the zero of the quadrant scale and the center of the horizontal axis of the pendant.

(3) A manually operated clutch mechanism, protected by the cover plate, is used to fix the position of the pendant when a sight is made. A thumbscrew acts on a spring to clamp the pendant in place. The index mark on the free end of the pendant is read against the quadrant scale to determine the angle.

c. Carrying Case. The clinometer is kept in a plywood case which is painted olive drab. The cover is fastened with two hooks and eyes. A metal handle is provided for carrying and the corners are protected by metal angles. The case is lined with felt at all places where the instrument rests.

5. DIFFERENCES IN CLINOMETERS ML-119-(*).

Clinometers ML-119-C, -D, and -E have cross lines etched on a cover glass in the wide end of the sighting tube. Clinometer ML-119-F has cross wires and no cover glass. In other respects, the four models of the clinometer covered by this manual are identical.

SECTION II

INSTALLATION AND ASSEMBLY

6. SITING (fig. 4).

a. Determining Base Line.

(1) The clinometer is used at a horizontal distance of 500 feet or more from the ceiling light projector. The usual base line is 1,000 feet. Use a steel tape to measure the base line; it must be accurate if correct ceiling heights are to be determined.

(2) If it is desired to use the clinometer at a distance greater or less than 1,000 feet, a table of altitude values should be computed for the exact base line, using the trigonometric formula given in paragraph 11.

(3) If the observer is not on the same level as the ceiling light projector, it will be necessary to determine the true base line, that is, the horizontal distance between the observation point and the projector, according to instructions in paragraph 11c on the use of cosines.

(4) Once the base line is determined, the same observation point should be used in making all sights with the clinometer.

b. Other Considerations.

(1) The observer should be out of the glare of lights when making a sight.

(2) It is preferable that the line of sight from the observation point to the projector should be from south to north in order to avoid the periodic inconvenience caused by moonlight.

7. UNPACKING.

The clinometer is always shipped packed in its carrying case. The instrument is completely assembled and ready for use when unpacked.

PART TWO

OPERATING INSTRUCTIONS

NOTE: For information on destroying this equipment to prevent enemy use, see the destruction notice at the front of this manual.

SECTION III

PRELIMINARY PROCEDURE

8. PREPARATION OF CLINOMETER ML-119-(*) FOR USE.

- a. Be sure the cross wires intersect at the center of the sighting tube.
- b. Be sure the pendant swings freely through its entire range without touching the quadrant plate or the cover.
- c. See that the clutch operates without friction.

SECTION IV

OPERATION OF CLINOMETER ML-119-(*)

9. USING CLINOMETER ML-119-(*)

a. Taking a Sight (fig. 1).

- (1) Stand at the end of the base line opposite the ceiling light projector.
- (2) Unclamp the pendant by turning the knurled knob to the left until it stops.
- (3) Holding the clinometer with the quadrant plate vertical, sight through the tube. Center the cross wires on the spot of light thrown on the cloud by the ceiling light projector.
- (4) When this spot is located, allow the pendant to come to rest before turning the thumbscrew on the side of the cover plate to clamp the pendant firmly in place. **Do not turn the thumbscrew while the pendant is swinging. Be careful not to throw the clinometer off its sight in clamping the pendant.**

b. Reading the Scale. Read the angle of elevation on the quadrant scale plate to the nearest $\frac{1}{2}^\circ$. This angle is indicated by the index mark on the pendant.

c. Averaging the Readings. Take three sights and use the average of the three to compute the height of the ceiling.

10. DESCRIPTION OF CEILING HEIGHT TABLE.

a. Values in the table in paragraph 18 are as follows:

- (1) Column 1 lists the angles of elevation in half-degree steps from 5° to 86° .
- (2) Column 2 lists the tangents of the angles.
- (3) Column 3 lists the cosines of the angles from 5° through 30.5° .
- (4) Column 4 gives the ceiling height where the horizontal base line is 1,000 feet.

b. After a sight is made with the clinometer the angle of elevation as read on the quadrant scale is located in column 1 of the table.

- (1) If the horizontal base line between the ceiling light projector and the observation point is 1,000 feet, the ceiling height may be read directly opposite the angle in column 4.

(2) If the base line is more or less than 1,000 feet it will be necessary to compute the ceiling height by means of the formula given in paragraph 11.

c. For convenience, each weather station may prepare an abbreviated table showing ceiling heights to the nearest hundred feet for corresponding intervals of observed angles of elevation. For instance, the table might be made up as follows:

Angle of Elevation	Reported Ceiling Height
5° to 8.5°	100 ft
9° to 14°	200 ft
14.5° to 19°	300 ft

11. FORMULA FOR COMPUTING CLOUD HEIGHT.

a. *Trigonometric Formula.* The elevation of the cloud is found by means of the following formula:

$$h = (b) (\text{tangent } A)$$

where h is the height in feet of the cloud above the observer, b is the length in feet of the base line, and A is the angle of elevation shown by the clinometer.

b. *Example.* Using the formula, with a base line of 750 feet and an observed angle of 52° the equation is

$$750 \times 1.2799 = 959.9 \text{ feet (ceiling height)}$$

(Since ceiling heights up to 5,000 feet are usually reported only to the nearest 100 feet, this would be recorded as a 1,000-foot ceiling.)

c. *Use of Cosine.* In determining the height of objects when a base line is laid out on sloping ground, the horizontal projection of the base line must be used. This may be found as follows:

(1) Determine this angle of inclination by sighting with the clinometer from the lower end of the base line toward the higher.

(2) Opposite the angle in column 1 of the table find the cosine of the angle in column 3.

(3) Multiply the measured length of the base line by the number found. The result is the horizontal projection of the base line.

(4) Using this number as the base line, compute the ceiling height by the method given in subparagraph *b* above. The result gives the height of the object above the observer's eye.

PART THREE

PREVENTIVE MAINTENANCE

SECTION V

PREVENTIVE MAINTENANCE TECHNIQUES

12. MEANING OF PREVENTIVE MAINTENANCE.

Preventive maintenance may be defined as a systematic series of operations performed periodically on equipment in order to maintain top efficiency in performance, to minimize unwanted interruptions in service, and to eliminate major break-downs. To appreciate the meaning of the term preventive maintenance, it is necessary to distinguish between preventive maintenance, trouble shooting, and repair. The primary function of preventive maintenance is to prevent major break-downs and the consequent necessity of repair. In sharp contrast, the primary function of trouble shooting and repair is to locate and correct existing defects. The importance of preventive maintenance cannot be overemphasized. The usefulness of an entire meteorological system depends upon each piece of meteorological equipment in the system being ready to operate at peak efficiency when needed. Consequently, it is vitally important that operators and repairmen of meteorological equipment maintain their equipment properly.

13. DESCRIPTION OF PREVENTIVE MAINTENANCE TECHNIQUES.

Most of the parts of any meteorological system require routine preventive maintenance. Those requiring maintenance differ in the amount and kind required. Because maintenance techniques cannot be applied indiscriminately, definite and specific instructions are needed. This section of the manual contains this type of specific instructions and serves as a guide for personnel assigned to perform the six basic maintenance operations, namely: FEEL, INSPECT, TIGHTEN, CLEAN, AD-

JUST, and LUBRICATE. Throughout this manual the lettering system for the six operations will be as follows:

F — Feel
I — Inspect
T — Tighten
C — Clean
A — Adjust
L — Lubricate

The first two operations establish the need for the other four. The selection of operations is based on a general knowledge of field requirements. Field use without continuous inspection and the continuous performance of necessary tightening, cleaning, and lubricating will result in most equipment becoming operationally erratic, undependable, and subject to break-down when it is most needed.

SECTION VI

PREVENTIVE MAINTENANCE ITEMS

14. PREVENTIVE MAINTENANCE CHECK LIST.

Item No.	Description	Operation	Daily	Weekly	Monthly	Echelon
1	Cross wires	IA	X			1st
2	Pendant	IA	X			1st
3	Cover glass	IC		X		1st
4	Accuracy of clinometer	I			X	1st
F Feel	I Inspect	T Tighten	C Clean	A Adjust	L Lubricate	

15. PREVENTIVE MAINTENANCE OF CLINOMETER ML-119-(*).

a. General Care. (1) When the clinometer is not in use, keep it in its case to protect the instrument from dust and dirt.

(2) Keep the pendant clamped to prevent it from being damaged by sudden movements or jolts.

(3) Dust the instrument with a clean, soft cloth.

(4) If the cover glass on Clinometer ML-119-C, -D, or -E is fingerprinted or dirty, wipe the outside with a damp cloth and polish with a soft cloth or tissue.

(5) Tighten all attaching screws, end bushing locknut, outer and inner knob, adjusting screw nut, and end thrust screw if necessary. **Do not change end bushing and clutch adjusting nut adjustments in this operation.**

b. Accuracy Check. Check the accuracy of the clinometer every month as follows:

(1) With the sighting tube in a horizontal position, rest the front edge of the quadrant scale plate on a level surface. The pendant should indicate 0° .

(2) If the instrument does not register accurately, return it to the repair depot for adjustment.

SECTION VII

LUBRICATION

NOTE: Lubrication is not required for Clinometer ML-119-(*). In fact, lubrication of this equipment may be harmful in that it may cause dirt deposits to build up on the wearing surfaces.

SECTION VIII

MOISTUREPROOFING AND FUNGIPROOFING

NOTE: Moistureproofing and fungiproofing are not required for Clinometer ML-119-(*).

PART FOUR

AUXILIARY EQUIPMENT (NOT USED)

PART FIVE

REPAIR INSTRUCTIONS

NOTE: Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on W.D., A.G.O. Form No. 468 (Unsatisfactory Equipment Report). For particulars see paragraph 17. If Form No. 468 is not available, see TM 38-250. Failure or unsatisfactory performance of equipment used by Army Air Forces will be reported on Army Air Forces Form No. 54 (unsatisfactory report).

SECTION IX

GENERAL REPAIR

16. REPAIRS TO CLINOMETER ML-119-(*).

a. Replacing Cover Glass on Clinometers ML-119-C, -D, or -E. Remove the three screws that hold the cover glass in place and pull out the cover glass assembly. Press the new cover glass into the end of the tube, aligning the tapped holes in the glass holder with the screw holes in the tube, and replace the screws.

b. Replacing Cross Wires on Clinometer ML-119-F. The ends of the cross wires are peened over at the outside of the tube. Drill out the end of the wires with 1/32-inch diameter drill and remove wires. Place new wires in position and peen the ends carefully to keep the wires in position.

c. Centering Pendant. If the pendant does not swing freely, with 1/16-inch clearance on either side, center it by adjusting the retainer nut or adjusting screw on either end of the thumb-screw arrangement.

- (1) Loosen the screw on the side toward which the pendant is to be moved.
- (2) Tighten the other screw until the correct position is assured.
- (3) Be sure that the pendant can swing freely in its arc after adjustment.

d. Disassembling Quadrant Plate. Friction in the clutch mechanism is probably caused by dirt and should be remedied as follows:

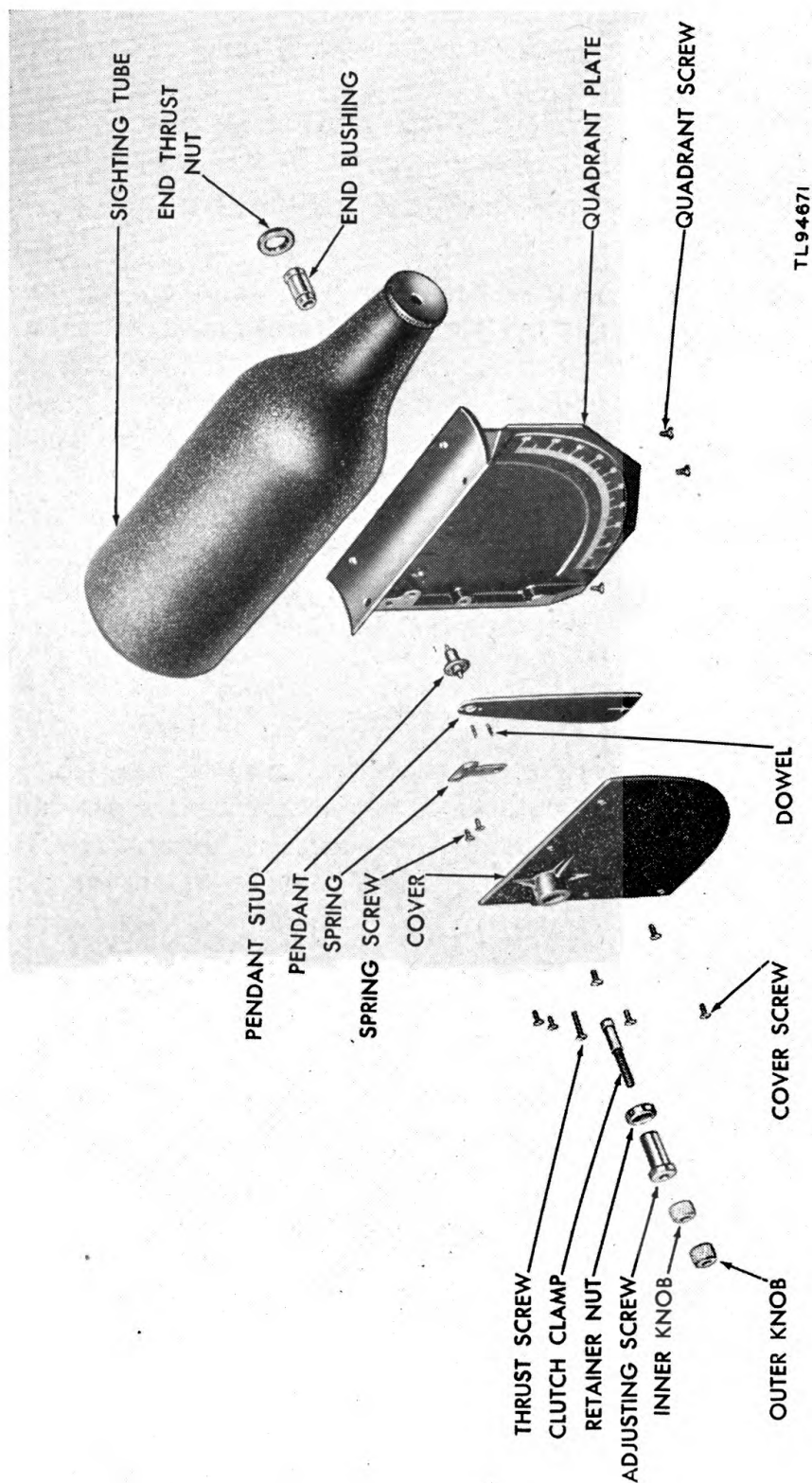


Figure 5. Clinometer ML-119-(*), exploded view.

(1) Disassemble the quadrant plate according to the exploded view of the instrument in figure 5.

(2) Inspect inside of end bushing, pendant stud, spring surfaces, and clamp stud face for scratches and dirt. These parts should be smooth and clean.

(3) Clean all wearing surfaces of the moving parts with a soft cloth dipped in Solvent, Dry-cleaning, Federal Specification P-S-661a. Wipe off the quadrant plate, quadrant cover and pendant, lightly.

e. Adjusting Parts. (1) Adjust end screw to eliminate side play and wobble in the pendant by loosening the nut with a spanner. With a face spanner turn the bushing right or left until the play is removed and the pendant swings freely without touching plate or cover. The pendant, when properly adjusted, should swing for 30 seconds before coming to rest.

(2) Adjust the clutch adjusting nut so that the clamp screw will have a maximum rotation of three-quarters of a turn. Loosen the locknut with a spanner. Turn the adjusting nut in or out with a spanner, retightening the locknut when the adjustment is completed.

17. UNSATISFACTORY EQUIPMENT REPORT.

a. When trouble in equipment used by Army Ground Forces or Army Service Forces occurs more often than repair personnel feel is normal, War Department Unsatisfactory Equipment Report W. D., A.G.O. Form No. 468 should be filled out and forwarded through channels to the Office of the Chief Signal Officer, Washington 25, D. C. Refer to TM 38-250 for complete instructions on the handling of this report.

b. When trouble in equipment used by Army Air Forces occurs more often than repair personnel feel is normal, Army Air Forces Form No. 54 should be filled out and forwarded through channels.

APPENDIX

SECTION X

TABLE OF CEILING HEIGHTS

18. TABLE OF ELEVATION ANGLES, TANGENTS, COSINES AND CEILING HEIGHTS

1	2	3	4
Angle of elevation °	Tangent	Cosine	Ceiling height (1,000 ft base) h
5	0.0875	0.9962	88
5.5	.0963	.9954	96
6	.1051	.9945	105
6.5	.1139	.9936	114
7	.1228	.9925	123
7.5	.1317	.9914	132
8	.1405	.9903	141
8.5	.1495	.9890	150
9	.1584	.9877	158
9.5	.1673	.9863	167
10	.1763	.9848	176
10.5	.1853	.9833	185
11	.1944	.9816	194
11.5	.2035	.9799	204
12	.2126	.9781	213
12.5	.2217	.9763	222
13	.2309	.9744	231
13.5	.2401	.9724	240
14	.2493	.9703	249
14.5	.2586	.9681	259
15	.2679	.9659	268
15.5	.2773	.9636	277
16	.2867	.9613	287
16.5	.2962	.9588	296
17	.3057	.9563	306
17.5	.3153	.9537	315
18	.3249	.9511	325
18.5	.3346	.9483	335
19	.3443	.9455	344
19.5	.3541	.9426	354
20	.3640	.9397	364
20.5	.3739	.9367	374
21	.3839	.9336	384
21.5	.3939	.9304	394
22	.4040	.9272	404

1	2	3	4
Angle of elevation °	Tangent	Cosine	Ceiling height (1,000 ft base) h
22.5	0.4142	0.9239	414
23	.4245	.9205	424
23.5	.4348	.9171	435
24	.4452	.9135	445
24.5	.4557	.9100	456
25	.4663	.9063	466
25.5	.4770	.9026	477
26	.4877	.8988	488
26.5	.4986	.8949	499
27	.5095	.8910	510
27.5	.5206	.8870	521
28	.5317	.8829	532
28.5	.5430	.8788	543
29	.5543	.8746	554
29.5	.5658	.8704	566
30	.5774	.8660	577
30.5	.5890	.8616	589
31	.6009		601
31.5	.6128		613
32	.6249		625
32.5	.6371		637
33	.6494		649
33.5	.6619		662
34	.6745		675
34.5	.6873		687
35	.7002		700
35.5	.7133		713
36	.7265		727
36.5	.7400		740
37	.7536		754
37.5	.7673		767
38	.7813		781
38.5	.7954		795
39	.8098		810
39.5	.8243		824
40	.8391		839
40.5	.8541		854
41	.8693		869
41.5	.8847		885
42	.9004		900
42.5	.9163		916
43	.9325		933
43.5	.9490		949
44	.9657		966
44.5	.9827		983
45	1.0000		1,000

1	2	3	4
Angle of elevation °	Tangent	Cosine	Ceiling height (1,000 ft base) h
45.5	1.0176		1,018
46	1.0355		1,036
46.5	1.0538		1,054
47	1.0724		1,072
47.5	1.0913		1,091
48	1.1106		1,111
48.5	1.1303		1,130
49	1.1504		1,150
49.5	1.1708		1,171
50	1.1918		1,192
50.5	1.2131		1,213
51	1.2349		1,235
51.5	1.2572		1,257
52	1.2799		1,280
52.5	1.3032		1,303
53	1.3270		1,327
53.5	1.3514		1,351
54	1.3764		1,376
54.5	1.4019		1,402
55	1.4281		1,428
55.5	1.4550		1,455
56	1.4826		1,483
56.5	1.5108		1,511
57	1.5399		1,540
57.5	1.5697		1,570
58	1.6003		1,600
58.5	1.6319		1,632
59	1.6643		1,664
59.5	1.6977		1,698
60	1.7321		1,732
60.5	1.7675		1,768
61	1.8040		1,804
61.5	1.8418		1,842
62	1.8807		1,881
62.5	1.9210		1,921
63	1.9626		1,963
63.5	2.0057		2,006
64	2.0503		2,050
64.5	2.0965		2,097
65	2.1445		2,144
65.5	2.1943		2,194
66	2.2460		2,246
66.5	2.2998		2,300
67	2.3559		2,356
67.5	2.4142		2,414
68	2.4751		2,475

1	2	3	4
Angle of elevation °	Tangent	Cosine	Ceiling height (1,000 ft base) h
68.5	2.5386		2,539
69	2.6051		2,605
69.5	2.6746		2,675
70	2.7475		2,748
70.5	2.8239		2,824
71	2.9042		2,904
71.5	2.9887		2,989
72	3.0777		3,078
72.5	3.1716		3,172
73	3.2709		3,271
73.5	3.3759		3,376
74	3.4874		3,487
74.5	3.6059		3,606
75	3.7321		3,732
75.5	3.8667		3,867
76	4.0108		4,011
76.5	4.1653		4,165
77	4.3315		4,332
77.5	4.5107		4,511
78	4.7046		4,705
78.5	4.9152		4,915
79	5.1446		5,145
79.5	5.3955		5,396
80	5.6713		5,671
80.5	5.9758		5,976
81	6.3138		6,314
81.5	6.6912		6,691
82	7.1154		7,115
82.5	7.5958		7,596
83	8.1443		8,144
83.5	8.7769		8,777
84	9.5144		9,514
84.5	10.385		10,385
85	11.430		11,430
85.5	12.706		12,706
86	14.301		14,301

SECTION XI

MAINTENANCE PARTS LIST

NOTE: No maintenance parts are authorized for this equipment.

